sistance of $5\frac{1}{4}$ inches of the fine platinum wire in the cross wire, 5 inches in the armature-branch, and 4 feet in the electro-magnet branch.

When there was no extra resistance in either of the branches, the length of the cross wire being only about a few feet, the intensity of the current in the electro-magnet branch, compared with that in the cross wire, was as 1 : 60; and when the resistance of the primary coil of the inductorium was interposed in the cross wire, the relative intensities were as 1 : 42.

In conclusion I will mention that there is an evident analogy between the augmentation of the power of a weak magnet by means of an inductive action produced by itself, and that accumulation of power shown in the static electric machines of Holtz and others which have recently excited considerable attention, in which a very small quantity of electricity directly excited is, by a series of inductive actions, augmented so as to equal, and even exceed, the effects of the most powerful machines of the ordinary construction.

February 21, 1867.

Dr. W. A. MILLER, Treasurer and Vice-President, in the Chair.

The following communication was read:—

"A brief Account of the 'Thesaurus Siluricus,' with a few facts and inferences." By J. J. Bigsby, M.D. Communicated by Sir R. I. Murchison, Bart. Received January 28, 1867.

I have been led to attempt the preparation of a general view of Silurian life, as far as now known, by my own frequent want of such a record or muster-roll of the constituent members of this great initiatory division of palæozoic zoology,—a task which has been made pleasant by some personal knowledge of two countries rich in the earlier formations.

I have been further encouraged by the great accumulations of the last few years, through the establishment in North America and elsewhere of numerous colleges, each of them having become the centre of more or less field-work. Far more aid still has been derived from many public surveys on a tolerably liberal scale. Nor can we forget the highly meritorious and successful labours which have been, and still are, carried on by private individuals in almost every part of Europe and North America.

As this undertaking required an exactitude and a critical skill in determining species and genera according to late improvements in classification, much beyond an ordinary acquaintance with Silurian life, after my materials were put together, I obtained the very valuable aid of Mr. J. W. Salter, late Palæontologist at the London Museum of Practical Geology.

I was then, through the kindness of Sir Roderick I. Murchison, Bart., allowed to submit my manuscript to Robert Etheridge, Esq., F.R.S.E.,

the present Palæontologist to the Institution over which Sir Roderick presides.

To the careful superintendence of these two eminent naturalists I am indebted for corrections and suggestions of the greatest importance, and particularly as relates to Britain and to Europe generally.

My matter has been principally found in the voluminous and truly priceless writings of Murchison, Sedgwick, Barrande, Sowerby, De Verneuil, James Hall, M^c^Coy, Salter, Billings, Angelin, Eichwald, Shumard, and Davidson—together with those of other authors, some of whom are scarcely of inferior merit*.

I have been favoured with many unpublished contributions from my friends Mr. Billings (the learned Palæontologist of the Canadian Survey) and Principal Dawson, F.R.S., of M^c^Gill College, Montreal,—also, through the kindness of Mr. Salter, from the Himalayas (Colonel Strachey, R.E.), from West Tasmania (Dr. Milligan), from South Wales (Henry Hicks, Esq.), and from the late Mr. Wyatt-Edgell.

I propose to give to this effort the name of "Thesaurus Siluricus." Besides its use for general reference in the closet and in the quarry, the 'Thesaurus' provides a high station from which the student may obtain a broad survey of the Silurian populations of the whole earth. It will assist in tracing the extent, shape, and varying depths of areas, in discovering regional affinities, differences, and those great zoological severances which we call breaks. By its aid we may compare horizons remote from each other, and, moreover, note the frequent changes of many kinds which take place while the epoch is working out its long history. It will place under our examination numberless communities of life, their constituents, habits, rise, and decline.

The 'Thesaurus' points to the universality (as defined) at times proximate everywhere, brings into prominence the riches, magnitude, and wide diffusion of the Primordial stage; illustrates the power of locality over life, and opens out the wonderful march of geographic dispersion through obstacles innumerable.

For a long period naturalists have been arranging the life of the globe into species, genera, orders, &c., with a view to the establishment of types as standards of comparison. It is from such data, well considered and generally acknowledged, that this 'Thesaurus' has been compiled.

As long as an individual mollusk remains unregistered it is deprived of its full usefulness; but even then it may reveal an important fact—as the trilobite speaks of the Palæozoic period, and a nummulite of the Tertiary.

* Agassiz, Beyrich, Bronn, Brongniart, Conrad, Dalman, D'Orbigny, Vicomte d'Archiac, Dawson, Emmerich, Emmons, Fischer, E. Forbes, Goldfuss, Green, Harkness, Hisinger, Haime, Honeyman, Rupert Jones, Ketley, Kutorga, Lawrow, Linnæus, Lovén, Lonsdale, M^c^Chesney, Meek, Meneghini, Milne-Edwards, Morris, Owen, Pander, Phillips, Portlock, Rœmer, Rouault, Sars, Sharpe, Safford, Swallow, Triger, Vanuxem, Von Buch, Volborth, Wahlenberg, Winchell, &c. &c.

Until some such record as the present is available, the labours of many living investigators (whose names rise to the lips spontaneously) will rest comparatively fruitless. It has hitherto not been possible to consider widely scattered existences in an aggregate form. Facts (many) have been stored up separately; but generalized truths have been rarely attained. This has not yet been done in a satisfactory manner, not even by Bronn or Goldfuss for any one epoch, and scarcely for the cretaceous period by the American geologist Mr. Gabb, although he has done well.

This 'Thesaurus' contains 7553 species, and therefore gives abundant scope for profitable study; but probably it does not give the tithe of the whole Silurian life yet lying buried in the wilds of the Arctic Circle, of Hudson's Bay, Labrador, the two Americas, Scandinavia, Australia, India, &c. &c. The more accessible countries frequently, to this day, yield new forms, although the search for them is capriciously and idly conducted, and is dependent often on the accident of a new public work or the presence of a competent observer. Many undescribed species are lying in local museums, still more in the great collection at Prague in the possession of a high Ecclesiastic in that city. Owing to the enlightened perseverance of M. Barrande, a few small parishes close to Prague have yielded nearly one-third of the whole earth's Silurian remains within present knowledge; and the greater part of these are not met with elsewhere. How wonderfully rich must be the universal Silurian fauna! What a splendid promise to the future explorer!

The 'Thesaurus' is in the form of a Table. After mentioning the genus (taken alphabetically), its author, and the date of its establishment, the species are successively named, and treated of under four or more heads, along one and the same ruled line. First comes the part of the stage in which it occurs, then, in a given order, its author and locality, or localities, in the column indicative of its proper stage.

More information is thus conveyed, it is believed, than by any other form of Table. The summary which is appended to each order shows some of the organic relations of the Silurian system in Europe and in America to each other; it shows, too, how very little we know as yet of this epoch in Asia and Africa; and, among other things, it tells us the numerical strength of the genera.

Permit me now to lay before the Society a few facts drawn from the mere surface of the 'Thesaurus,' and only in the way of summary or brief remark, in order to suit the purpose of this evening. Much more than this the careful registration of more than 50,000 facts has prevented me from doing.

The Table A (page 375) gives the numerical amount of the Silurian flora and fauna as known in the years 1856 and 1866 respectively.

TABLE A.—Comparative number of species known in 1856 and 1866.

	Plantæ.	Amorphozoa.	Foraminifera.	Annelida.	Hetero-Pteropoda.	Polyzoa.	Cœlenterata.	Echinodermata.	Trilobitæ.	Entomostraca.	Brachiopoda.	Dimyaria.	Monomyaria.	Gasteropoda.	Cephalopoda.	Pisces.	Class uncertain.	Total.
Prize Essay	18	19	..	10	63	76	108	93	425	8	579	113	14	151	299	10	9*	1995
Thesaurus ...	76	125	25	132	241	389	496	479	1400	247	1408	446	136	721	1192	34	6	7553

This Table, taken from Bronn's Prize Essay published in 1856, and from the 'Thesaurus Siluricus,' shows that within the last ten years the number of known species has more than trebled.

Universality.

In the spirit of the following definition, it would appear that the Silurian system is universal—that is, it overspreads the whole earth more or less completely,—and that its component parts were laid down in a proximate time,—statements approved by M. Barrande, Bull. n. s. xii. 361. Definition:—"*A formation may be considered to be universal when it occupies large and small areas in very many parts of the earth, often remote from and even antipodal to each other, when it is always of like stratigraphical relations, is composed of like materials, and contains numerous genera in common, together with some representative and some identical species.*"

In support of our application of this definition to the Silurian system, the 'Thesaurus' exhibits the widest possible distribution of its fauna—a fauna, it must be remembered, which is pure from admixture with that of any other epoch which might possibly have been progressing at the same time.

The 'Thesaurus' contains many examples of the same species being in twenty to twenty-five different countries, large and far apart—the same creature or creatures marking the route from land to land.

Table B, drawn up under the inspection of Mr. Salter, presents 195 species common to regions very remote from each other, some of them being antipodal—a fact which tells the more forcibly from the tenacity with which a large part of Silurian life clings to locality as well as to horizon. 179 species are common to Europe and America. Sixty Silurian genera have been brought from South Australia by Mr. Selwyn, the chief Geological Surveyor of that colony; and Professor M'Coy has met with in that country a Siphonotreta, a Phacops, and eighteen species of Graptolites absolutely identical with those of North America and of Europe. The Professor loudly expresses his surprise and delight. According to M. Barrande, *Orthoceras bullatum* (Sowerby) is at Melbourne (Australia) and in Ireland, Bohemia, Germany, and Russia. *Conocoryphe depressa* is both in Wales and Texas, one of the American States. Western Tasmania, the

* Morris, Catal. p. 362.

Himalayas, Russia, North and South America, and many other regions offer ample fossil evidence of the general presence of the constituents of this period.

TABLE B.

Kingdom or Order.	No. of Species.	America and Europe.	America, Europe, and Australia.	America and Australia.	Europe and Australia.	Total.
Plantæ	74					
Amorphozoa	120	5	.....	.....	.....	5
Foraminifera	25					
Annelida	132	4	.....	.....	.....	4
Hetero-Pteropoda	239	16	.....	.....	.....	16
Bryozoa	383	6	3	6	5	20
Zoophyta	432	18	.....	.....	.....	18
Crinoidea	456	7	.....	.....	.....	7
Cystidea		1	.....	.....	.....	1
Asteriada		1	.....	.....	.....	1
Trilobitæ	1414	21	2?	.....	.....	23
Entomostraca	242	1	.....	.....	.....	1
Brachiopoda	1372	64	.....	.....	.....	64
Monomyaria	123	2	.....	.....	.....	2
Dimyaria	439	9	.....	.....	.....	9
Gasteropoda	715	9	.....	.....	.....	9
Cephalopoda	955	15	.....	.....	.....	15
Pisces	34	.....	.....	.....	.....	...
	7155	179	5?	6	5	195

The Silurian beds, it must be borne in mind, are usually visible in mere shreds and remainders, met with in any one place only as a stage or a part of a stage, the other portion being covered for perhaps thousands of square miles by more recent deposits, or removed by denudation; or it may be that certain stages have never existed, as we see in Arctic America with respect to the Lower Stage; while in the South, as in Sardinia, France, and Spain, it is the Upper Stage that is wanting, or very nearly so.

But the visible geographical spread of these strata is often very great. So extensive are the Silurian areas of North America (2000 miles across) that it only needs a short and easy step to induce a belief in a former universal prevalence and domination of this system.

Sufficient territory resting on Silurian rocks has been spared from oscillatory action to enable us to trace it in one or other of its parts over a large part of the earth. We follow it circuitously from England to Australia, or to America—the interspaces being filled up either by sea, by newer rocks, or by kindred palæozoic strata, which themselves irresistibly bespeak its frequent continuous existence near at hand.

This is only a fragment of the argument in favour of the doctrine of Universality of epochs, as just defined.

Locality.

The 'Thesaurus' brings conspicuously into view the great influence of

locality on the nature and amount of life, in the same way as we observe at the present time. As each region yields up its fauna to the collector, much of that fauna is found to be new, the bond of connexion with other Silurian districts being in great measure generic.

The physical conditions of sea and land being necessarily local, produced as they are from time to time by agencies limited in space, the dwellers among these conditions must in a certain measure be local too, and typical—subject at any moment to removal. The first occupants of any spot who shall point out?

The maximum of life, meaning by that expression the largest combination of abundance, variety, and rank, is local. It may take place at the beginning of a stage, or of an epoch, in the middle, or at the end, being governed principally by the nature of the sediment. The rich Primordial beds of Western Newfoundland and of Quebec, the crowded Pleta beds of Russia and of Esthonia, the Trenton Limestone of America, the Mid-Silurian rocks of Bohemia* (*E. e.* 1, 2), some of those of Wales, the Lower Helderberg group of New York, are conspicuous examples of this. Parts of the Llandovery stage of Wales and of New York (U. S. A.) present a great dearth of life, and for a well-known reason. How barren are the vast accumulations of Lower Silurian in Bolivia, as at present believed! The Potsdam Sandstone of the valleys of the St. Lawrence and the Mississippi shows no signs of life for hundreds (and perhaps thousands) of square miles, save in small oases peopled chiefly by Lingulæ in incalculable millions of individuals.

Nearly equal areas of Central North-east America (N. latitudes 50°–32°) and Europe may have received about the same attention; but the latter, so far, has proved the richer by above a thousand species, as we see in the subjoined Table C.

Table C.—Known species of America and Europe compared.

Orders.	Species.		Orders.	Species.	
	America.	Europe.		America.	Europe.
Plantæ (kingd.)	56	20	Carried forward...	964	931
Amorphozoa	58	64	Asteriadæ	29	29
Foraminifera	.....	25	Crust. { Trilobites	396	1008
Annelida	36	98	Crust. { Entomostraca ...	75	170
Hetero-Pteropoda	96	144	Brachiopoda	678	721
Polyzoa (Bryozoa)	203	177	Monomyaria	78	56
Cœlenterata (Zoophyt.)	262	245	Dimyaria	181	241
Crinoids	193	93	Gasteropoda	421	274
Cystidea	56	63	Cephalopoda	321	861
Sedis incertæ	4	2	Pisces	2?	34
	964	931		3145	4325

* The extraordinary abundance of Trilobites, Cephalopoda, &c. here is accounted for by the beds being calcareous and overlain by trappose masses, in place of the sand and gravel more commonly seen.

The Cephalopoda, Crustacea, Brachiopoda, and Annelida of Europe appear to largely exceed in number of species those of North America, while in nine Orders (see Table C) the two hemispheres hold nearly equal quantities. America greatly surpasses Europe in the number of its Crinoids, and to a smaller extent in Plantæ and Gasteropoda. I am not prepared with any inference from these facts. We know that the mineral constitution, and the past external influences in these several parts of the earth are different—not that the first is as influential as has been supposed.

Many species are marked as undefined in the 'Thesaurus,' because they are often only known by simple fragments.

About a thousand species have never been seen but in one locality. At least 200 Cyrtocerata are huddled together in the two contiguous parishes of Lockhov and Kozorz, near Prague, and, with other mollusks there, are unknown elsewhere. Other instances of this might be cited.

The two Silurian districts of Sardinia, with not a few fossils in common with Spain, although tolerably well examined by La Marmora and Meneghini, have not hitherto produced a Trilobite; nor has Spain given up a *Pentamerus*, as far as can be learnt. Out of our sixty species of *Asaphus* only one is known in Bohemia. Silurian fish are only mentioned as existing in Britain, Bohemia, and Russia; but doubtless they are in other Silurian areas.

The Trilobite genus *Dikelocephalus* of D. D. Owen contains thirty species. Only three are found in two places. Twelve species are near Quebec, and there only. Nine others are Minnesotan, on the Upper Mississippi; while the States of Texas and Vermont, on Lake Champlain, have each one, and Wales three—all distinct species. Western Newfoundland, although primordial, is thought to be without this remarkable genus.

Each of the twenty-seven known species of the Heteropod Maclurea is confined to one spot; twenty are American; and of these, eleven are confined to Newfoundland West.

Of the forty-five species of the genus *Trochoceras* (Cephalopoda), forty-three are restricted to the vicinity of Prague; and of these twenty-seven inhabited the very small space of 4–6 square miles, in company with many other mollusks. The Brachiopoda of Bohemia are mostly in the Fauna F, and in the two small districts of Konieprus and Mnienian.

Out of 270 species of *Orthis* only two are believed to be in Nova Scotia, and of the 109 species of the Gasteropod Murchisonia, again, two, but not one of the elsewhere most abundant genus *Pleurotomaria*.

On the other hand, Nova Scotia holds one-half of all our Cleidophora; and Tasmania is singularly rich in *Palæarca*, while the Point Levi shales are crowded with the Graptolite family, of extreme beauty, and rarely found in other countries. We further observe that, as it is with the horizontal disposition of Silurian life, so it is with the vertical: only twelve per cent. leave their native horizon, as we shall see.

These few facts have been selected from many, to show the strong tendency to localization inherent in the Silurian fauna.

Primordial Stage.

The 'Thesaurus' amply manifests the great extent of this stage, and the high significance of its teachings; but we shall here only speak of a few leading facts relating to Canada, extracted from the 'Thesaurus' itself.

While waiting for the results of field-work now in progress, Mr. Billings has treated this subject with his usual great ability in the first volume of the work entitled 'The Palæozoic Fossils of Canada.'

The Primordial stage of Barrande (Taconic of Emmons) is truly Silurian, and forms the base of that epoch.

In the valley of the St. Lawrence it may average 8600 feet in thickness.

Resting horizontally in America on the inclined Laurentian rocks, the lower break is complete in every respect; while the upper break is very nearly so, although purely organic.

It divides naturally into *Lower* and *Upper* Primordial,—Potsdam sandstone constituting the former, and calciferous sandstone, with the enigmatical Quebec group, the latter, with a few layers of chazy limestone superadded.

The whole flora and fauna of the Primordial stage, American and European, amount to 919 species, while those of the St. Lawrence Valley alone are 560. The western, therefore, seems to be the richer of the two hemispheres; and this comes out still more distinctly in stating the fact that the Primordial genera at present known in America are 134, and those of all Europe 83.

Table D (below) has been constructed from the 'Thesaurus.' It exhibits numerically the zoological contents and the zoological relations of the several parts of the Primordial stage; and we see that the differences are great.

Table D.—The American Flora and Fauna of the Primordial Stage (principally Canadian).

		Plantæ.	Amorphozoa.	Annelida.	Hetero-Pterop.	Bryozoa.	Zoophyta.	Crinoidea.	Cystidea.	Asteriada.	Dimyaria.	Monomyaria.	Gasteropoda.	Brachiopoda.	Cephalopoda.	Trilobitæ.	Entomostraca.	Pisces.	Total.
Upper	Quebec Group	...	4	21	19	44	2	...	...	...	5	...	57	42	34	96	3	...	327
	Calciferous Sandst.	6	5	3	5	...	1	...	...	...	1	...	39	6	19	6	2	?	93
Lower	Potsdam Sandstone	16?	2	4	2	1	...	...	1	...	...	...	3	31	...	74	6	...	140
	Total	22	11	28	26	45	3	...	1	...	6	...	99	79	53	176	11	...	560

Great interest attaches to every part of this stage, but especially to the

Quebec group and its ill-understood connexion with the immediately contiguous strata.

An intimate acquaintance with this group near Quebec leads me to believe that there, at least, it is a displaced, crumpled, and fractured mass of schist, with thin beds of limestone and calcareous conglomerate interleaved, the last crowded with molluscan and crustacean life.

It is above the Potsdam Sandstone, and on or near the horizon of Calciferous sandstone and the lower layers of Chazy Limestone (Logan and Billings, Report, 1863). Into these (with a distinct tendency still higher) in other parts of North America, the Quebec group probably becomes fused, and assumes their horizontal position, mineral character, and many of their organic contents.

The fauna of the Quebec group, consisting of 327 species at Point Levi (Quebec) and in Western Newfoundland, is peculiar, and, of course, is only found there, with the exception of thirteen species found elsewhere in Calciferous sandstone, and eight in Chazy Limestone. They are one-sixteenth of the whole, and are as follows :—

Calciferous Sandstone :—*Lingula Mantelli, L. acuminata, L. Irene, Cameralla calcifera, Helicotoma gorgonia, H. uniangulata, H. perstriata, Pleurotomaria calcifera, P. postumia, Holopœa dilucula* ?, *Ecculiomphalus Canadensis, Murchisonia Anna, Piloceras Canadense* (Billings).

Chazy Limestone :—*Ecculiomphalus Atlanticus, Maclurea Atlantica, Stromatopora compacta* (running into B+BL), *Climacograptus antennarius, Ptilodictya fenestrata* ?, *Leperditia amygdalina, Camerella varians, Cheirurus prolificus* (Billings).

This group contains, besides the thirteen species just enumerated, 174* allied to those of the Calciferous Sandstone of Central North America, or more or less westward of Montreal. It is this which connects it closely with the sandstone. However, 140 remain typical.

The fossils of Chazy Limestone met with in the Quebec group only belong to a few of the basement beds of the former, because these almost immediately, upwards, change into a compact mass of crushed Crinoids, Cephalopoda, Gasteropoda, &c. (143 species)—all quite new, and alien from the life below.

The Calciferous Sandstone, always truly primordial, has in the Canadas and the United States of America 375 species, overspreading vast areas. They may be separated into three sets :—

1. Thirteen enter the Quebec group.
2. One hundred and seventy-four are the allies of that group.
3. One hundred and eighty-eight are foreign to it, and for the most part typical.

Like its two sister groups, the Calciferous Sandstone is shown, in the middle line of Table D, to display a remarkable tendency to abound in complex and powerful existences, and to paucity in the simple species, in-

* These numbers are for the present only approximate, and may be altered.

TABLE E.—A synoptical view of Silurian Life, with special reference to vertical Range or Recurrence.

	Species typical of one Horizon.							Species Recurrent.																																	
	Primordial Silurian.		Lower Silurian.	Middle Silurian.	Upper Silurian.	Total (typic.)	Grand Total	Primordial.								Lower Silurian.				Middle Silurian.				Upper Silurian.				Total Recurrents.	Per cent. on Typical Species.												
								Lower.				Upper.																															
								Horizons.				Horizons.				Horizons.				Horizons.				Horizons.																			
	Lower.	Upper.						2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5															
Plantæ	14	...	37	17	5	73	82	4	...	...	...	...	...	...	...	4	...	...	...	...	...	...	...	1	...	...	...	9	11												
Amorphozoa	4	6	56	7	25	98	110	...	...	...	...	...	1	...	...	6	4	...	...	...	...	...	...	1	...	...	...	12	11												
Annelida	10	7	34	8	26	85	99	...	1	...	...	...	...	...	...	4	1	4	...	...	1	...	...	2	1	...	...	14	15												
Hetero-Pteropoda	8	22	98	9	38	175	212	3	2	...	...	...	...	...	...	21	1	4	...	3	...	...	...	3	...	...	...	37	16												
Polyzoa	4	51	149	26	64	294	333	...	...	...	...	1	...	...	...	17	9	4	1	6	...	...	...	1	...	...	...	39	11												
Cœlenterata	...	2	97	35	179	313	384	...	...	...	...	...	...	...	1	30	13	8	...	12	2	...	...	5	...	...	...	71	20												
Crinoidea	...	...	99	10	132	241	267	...	...	...	...	...	...	...	...	13	1	...	...	3	2	...	...	7	...	...	...	26	10												
Cystidea	...	1	64	2	31	98	101	1	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	3	3												
Asteriada	...	1	24	4	21	50	54	...	...	...	...	...	...	...	...	2	...	1	...	...	...	...	...	1	...	...	...	4	9												
Trilobitæ	178	162	538	43	264	1185	1331	3	...	...	...	4	...	...	...	69	15	5	2	14	2	...	...	27	3	2	...	146	11												
Entomostraca	11	9	55	4	115	194	205	...	...	...	...	1	...	...	...	4	1	...	...	2	1	...	...	2	...	...	...	11	5												
Brachiopoda: Orthis	8	17	113	12	56	206	243	...	...	...	...	...	...	...	...	21	8	1	1	2	1	...	...	2	1	...	...	37	8												
Rhynchonella	...	1	20	22	73	116	141	...	...	...	...	...	...	...	...	7	2	2	...	7	2	...	...	4	1	...	...	25	27												
Strophomena	...	2	29	9	15	55	80	...	...	...	...	...	...	...	...	7	8	2	...	...	3	...	...	4	...	1	...	25	31												
all other Species	40	30	216	80	299	665	759	...	1	...	...	...	...	...	...	24	13	4	1	19	6	2	...	19	6	...	...	94	12												
Monomyaria	...	...	27	5	70	102	121	...	...	...	...	...	...	...	...	5	3	...	...	3	1	1	...	6	...	...	...	19	16												
Dimyaria	1	5	211	25	127	369	426	...	...	...	...	...	...	...	...	29	6	1	...	8	1	...	...	10	2	...	...	57	13												
Gaster.: Murchisonia	...	15	37	6	26	84	105	...	...	...	...	...	...	...	...	15	...	...	...	1	1	...	...	4	...	...	...	21	20												
Pleurotomaria	1	18	56	11	20	106	125	...	...	...	...	...	2	...	...	15	...	...	...	...	...	...	...	1	1	...	...	19	17												
all other Species	5	30	171	23	131	360	389	...	...	...	...	1	...	...	...	12	1	1	...	7	3	...	...	5	...	...	...	30	7												
Cephal.: Gomphoceras	...	...	4	58	16	78	82	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2	...	...	...	4	5												
Cyrtoceras	...	7	36	225	35	303	312	...	...	...	...	...	...	...	...	7	...	...	...	2	...	...	...	9	...	...	...	9	3												
Orthoceras	...	25	128	96	95	344	409	...	...	...	...	...	1	...	...	28	10	5	...	5	3	...	...	14	...	...	...	66	16												
all other Species	...	13	111	105	69	298	321	...	...	...	...	...	...	...	...	11	1	2	...	1	...	...	...	8	...	...	...	23	7												
	284	424	3010	624	1931	5891	6691	11	4	...	...	7	4	...	1	384	98	44	5	95	29	3	...	129	15	3	...	801	12												

dividuals, nevertheless, being prodigiously numerous. Trilobites are here very few.

Potsdam Sandstone is rich in Trilobites, Brachiopoda, and Fucoids, but in every other form is very poor; and yet it possesses a Cystid.

In the Primordial group, therefore, we find numerous representatives of nearly every marine Invertebrate; and we have a startling example of the sudden development in very early times of the highest types of molluscan life, Nautili, Lituites, Trilobites, Protichnites, &c., dwelling, even then, in well adjusted communities.

Most of these facts are taken from the 'Thesaurus;' but this interesting portion of the 'Thesaurus' itself is the gift of Barrande, Emmons, Hall, Logan, and Billings *, and is the fruit of their unwearied study in the city, and of their toil in the field.

Recurrence.

A few words on the subject of recurrence, or the vertical range of Silurian life.

What can be more unexpected, or more wonderful, than the upward passage by a filial succession, through stages and epochs, of a mollusk during centuries inconceivably numerous! What an almost interminable series of posterities must have followed the first ancestor! The doctrine of limited duration in species must have its exceptions.

The 'Thesaurus' enumerates 803 recurrents, or 12 per cent. of the whole known life of the epoch—a very notable proportion,—still leaving 6200 species faithful to one horizon.

The synoptical Table E, compiled from the 'Thesaurus,' exhibits many details, and may be trusted approximately, although about 400 species have been passed by for want of sufficient information. It numbers separately the species typical of *one* horizon, and the species frequenting *more than one* horizon (being recurrent). It also introduces some of the greater genera, such as *Orthis, Murchisonia,* &c.

The species are arranged under the heads "Primordial," Lower," "Middle," and "Upper Silurian;" and in the case of the recurrents the number of horizons occupied by them is shown by the figures 2, 3, 4, 5. Thus we find that 69 Lower Silurian Trilobites occupy two horizons, 15 three, and 2 five horizons.

The percentage is stated in the last column, next to that containing the total recurrence of each order.

The Primordial stage only gives	2·7	per cent. of recurrency.
The Lower Silurian	16	,,
The Middle	20	,,
The Upper	8	,,

* It is well to note that, under Sir William E. Logan's able superintendence, we owe the splendid Primordial harvest gathered in Newfoundland and Anticosti, to the diligence and skill of Mr. Richardson, an explorer in the employ of the Canadian Geological Commission.

The orders vary greatly in respect to recurrency. There is none among fossil fish. In Cystidea it is only 3 per cent., in Gomphoceras 5 per cent., and is greatest in Strophomena, 31 per cent.

Although a considerable number of inferences have been prepared, I shall only venture now to introduce a few.

1. Recurrence is universal, both as to time and place.

2. Recurrences seem to be most numerous in the lower stages of the epoch; but further research may teach otherwise.

3. Species do not often change their horizon, not even when placed in countries far apart.

4. The same species may be typical of a single horizon in one country and recurrent in another.

5. Recurrency shows that a mollusk is not necessarily confined to any one community, but may find a home and flourish in several successively.

6. The number of recurrents measures the amount of change in conditions.

7. Communities, genera, and species disappear sporadically, except in the rare case of a catastrophe.

8. Recurrency is a measure of viability.

Extra-epochal Recurrence.

Few things demonstrate more plainly the sterner discipline now prevailing than the reduction by Mr. Salter to 133 of the 439 palæozoic species which I had tabulated as extra-epochal, although they had the sanction of the best palæontologists of the last fifteen or twenty years.

My Table, as originally made out, deals with the five palæozoic epochs, but in this place only with the forty-two Silurian species which leave for the higher periods. To these, recently, several interesting additions have been made.

I. These recurrents are mostly distinct from the intra-epochal, owing to their first appearance being in the Upper Silurian stage.

II. With the exception of *Chonetes sarcinulata*, they all stop within the Devonian Period.

III. The greater part of these recurrents are of low rank; 20 are Brachiopoda; 11 Zoophytes, 1 an Amorphozoa; 7 are Gasteropoda; 3 Cephalopoda; and 1 Trilobite. *Manon deforme* and *Orthis rugosa*, Lower Silurian fossils, reappear in Devonian, but not in Upper Silurian, where they are "presumably"—to use an expression of Mr. Etheridge.

IV. These species are very migratory—few being found in two epochs in the same country, but in different countries.

V. Opportunities of escape into a new epoch have been common; but the ways and means are frequently concealed by denudations, &c.

VI. Acclimatization must have been necessary.

VII. The length of individual life in proportion to specific extra-epochal life is almost as a unit to infinity.

TABLE F.—Geographical Summary of Silurian Life.

Orders.	America.	Europe.	India.	Africa.	S. Australia.	Tasmania.	Common.	
Plantæ	56	20	...	...	...	...	...	* Tibet.
Amorphozoa	62	63	4*	...	1	1	6	To America and Europe.
Rhizopoda	...	25?	...	...	...	...	...	Not definitely accepted.
Cœlenterata	262	245	1	...	2	1	27	To America and Europe.
Echinodermata. Crinoidea	193	93	...	...	2	...	6	" "
Echinodermata. Cystidea	56	53	...	...	20	...	3	" "
Echinodermata. Asteriada	29	29	...	...	...	...	1	" "
Annelida	36	98	...	...	1	...	7	" "
Crustacea. Trilobitæ	396	998	10	...	11	...	30	Various.
Crustacea. Phyllopoda, Ostracoda	77	170	...	...	2	...	5	
Polyzoa	203	177	2	...	20	...	23	Various.
Brachiopoda	678	721	22	...	19	...	65	Various.
Monomyaria	78	56	...	...	2	...	5	To America and Europe.
Dimyaria	181	241	3	...	8	19	12	" "
Pteropoda & Heteropoda	103	145	1	...	3	1	15	" "
Gasteropoda	421	274	9	...	9	13	10	" "
Cephalopoda	321	861	5	...	...	8	16	" "
Pisces	...	34	...	...	...	...	...	
Incertæ Sedis	4	2	...	...	...	...	...	
	3156	4305	57	...	100	43	231	

3156+4305=7461 species.

Geographical Distribution of Silurian Life.

The 'Thesaurus' tends to show that North America, east of the Rocky Mountains, may probably be divided into two areas,—the one to the north of 57° (or of Lake Superior) being chiefly Upper Silurian, resting on crystalline rocks, the one to the south of that line, down to the Gulf of Mexico, on the contrary, being fully developed in some part of this great space.

It exhibits the regrettable fact that Asia, Africa, and Australia, taken together, have hitherto yielded only 200 species of Silurian remains; but this arises from the absence of exploration.

I have not yet had opportunity to bring together, harmonize, and compare the Silurian life of the several countries of Europe. The accomplishment of such a task might produce some definite truths, and many more probabilities. Either this vast region would prove to be one great Silurian area, with barriers here and there, and with certain channels of communication, and to be the result of many operations throughout a long interval of time; or it might turn out that the Silurian deposits and their fossils occupy three separate areas:—(1) the Britanno-Scandinavian, which has all the three stages, and the Primordial; (2) the Bohemian, at

present of peculiar interest; and (3) the middle and southern area, found in France, Spain, and Sardinia, almost wholly Lower and Mid-Silurian.

Under this head of geographical distribution we have to deal with some curious phenomena—such as concern birthplace or first appearance, generic and specific, the duration of life, tolerance of conditions, mineral habitats. Migration possesses great interest, with its marks, causes, and modes, with its power, direction, and rate of progress, &c.

The transport or removal of dead organic matter from place to place, the "*remaniement*" of French geologists, is an important agency under several aspects, especially in the formation of extensive sheets of rock.

It now has become proper to bring to a close these few observations, or rather this enumeration of heads of Natural-History subjects, by expressing a confident hope that this compilation will find many and well qualified interpreters, and will be useful to geologists in general.

February 28, 1867.

Lieut.-General SABINE, President, in the Chair.

The following communications were read:—

I. "On a Transit-Instrument and a Zenith Sector, to be used on the Great Trigonometrical Survey of India for the determination, respectively, of Longitude and Latitude." By Lieut.-Colonel A. Strange, F.R.S. Received February 16, 1867.

In 1862 the Secretary of State for India in Council sanctioned the provision of an extensive equipment of geodesical and astronomical instruments of the first order for the use of the Great Trigonometrical Survey of India; and he did me the honour to entrust to me the task of designing and superintending their construction. After several modifications, the following list was adopted:—

One Great Theodolite, with a 3-feet Horizontal Circle. By Messrs. Troughton and Simms.

Two Zenith Sectors. By Messrs. Troughton and Simms.

Two 5-feet Transit-Instruments. By Messrs. T. Cooke and Sons, York.

Two Smaller Transit-Instruments (*German form*). By Messrs. T. Cooke and Sons, York.

Two 12-inch Vertical Circles (*German form*). By Messrs. Repsold, Hamburg.

Two Galvanic Chronographs for registering Transit-Observations. By MM. Secretan and Hardy, Paris.

Three Astronomical Clocks. By Mr. Charles Frodsham.

The whole of these are nearly ready, and I take the opportunity of now submitting two of them (a 5-feet transit-instrument by Messrs. Cooke, and